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- (54) **SYSTEM AND METHOD FOR E911 LOCATION PRIVACY PROTECTION**
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See application file for complete search history.

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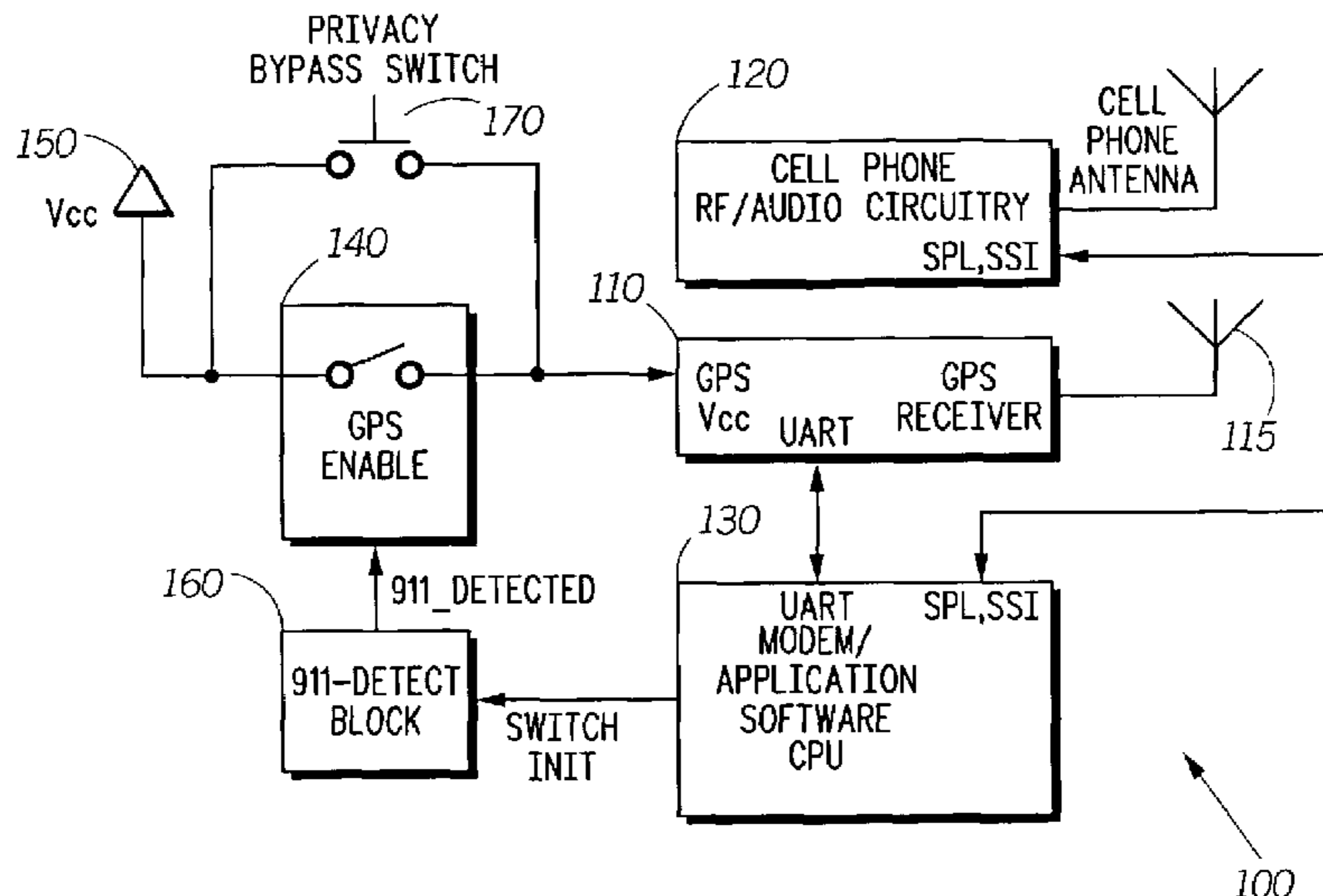
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(57) **ABSTRACT**

The invention relates to a system that enables power to be selectively applied to GPS circuitry in a cellular telephone or other mobile device only when a specific user input is detected. In one embodiment, power to the GPS circuitry may be enabled only when the user strikes the keys "9-1-1." In other embodiments, other types of GPS enablement or disablement may be employed, such as selectively decoupling the GPS antenna. In another embodiment, the user may depress a privacy bypass button, which alternately enables and disables power to the GPS circuitry. Cellular telephones or other communication devices may therefore activate GPS location service during an emergency call, or when a user wishes to allow their location to be determined, but protect the privacy of that user's location and movement at other times.

8 Claims, 3 Drawing Sheets



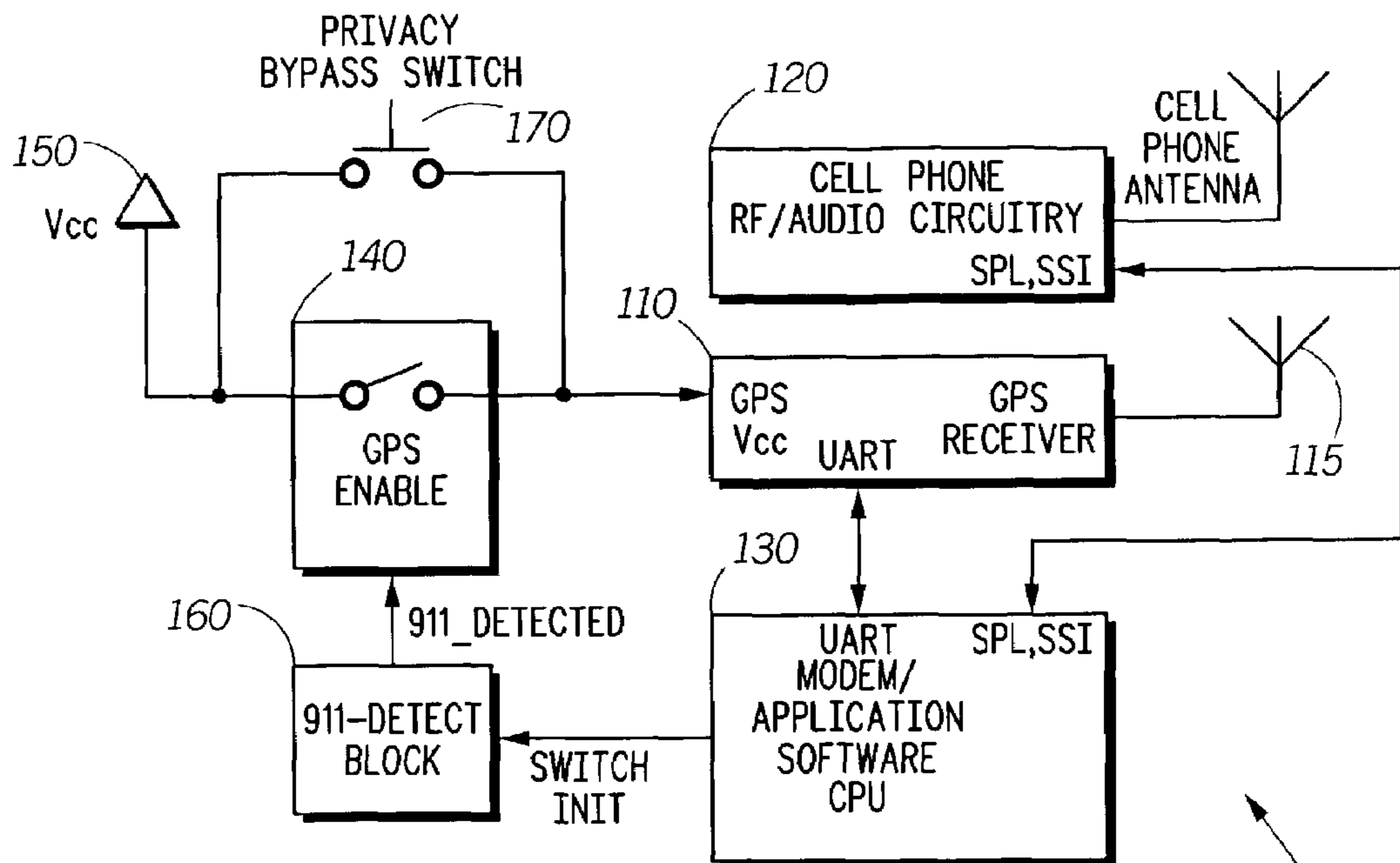


FIG. 1

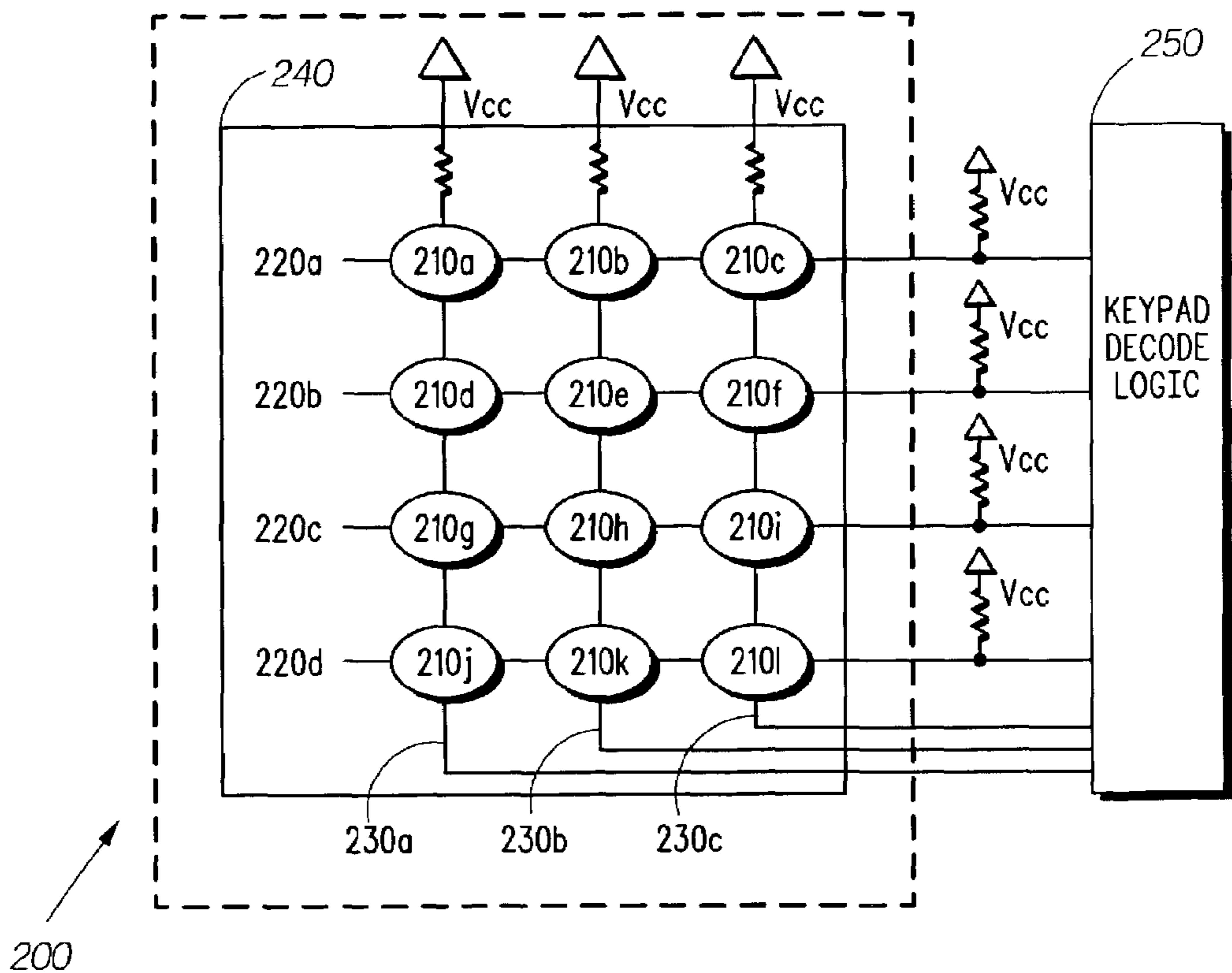
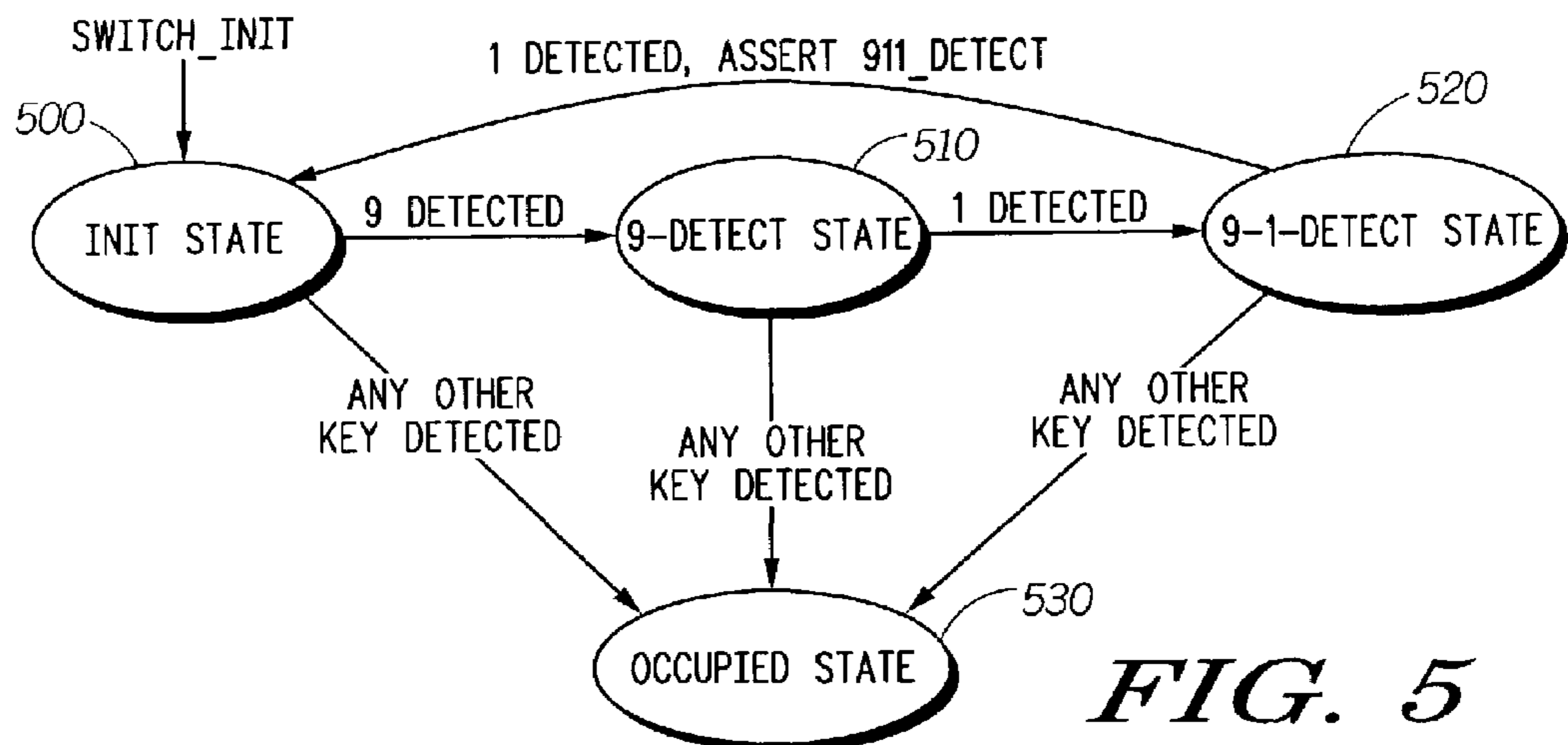
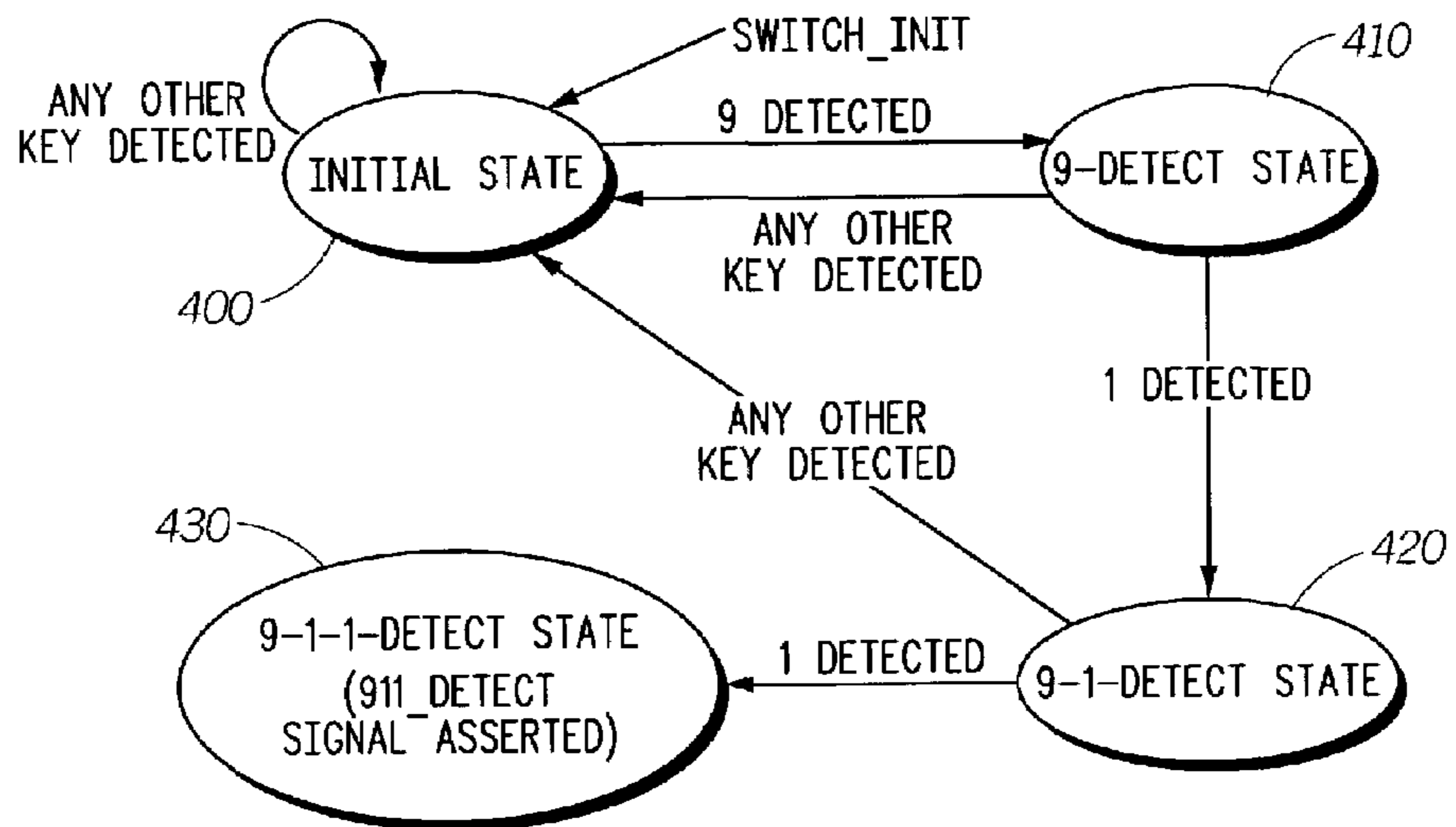
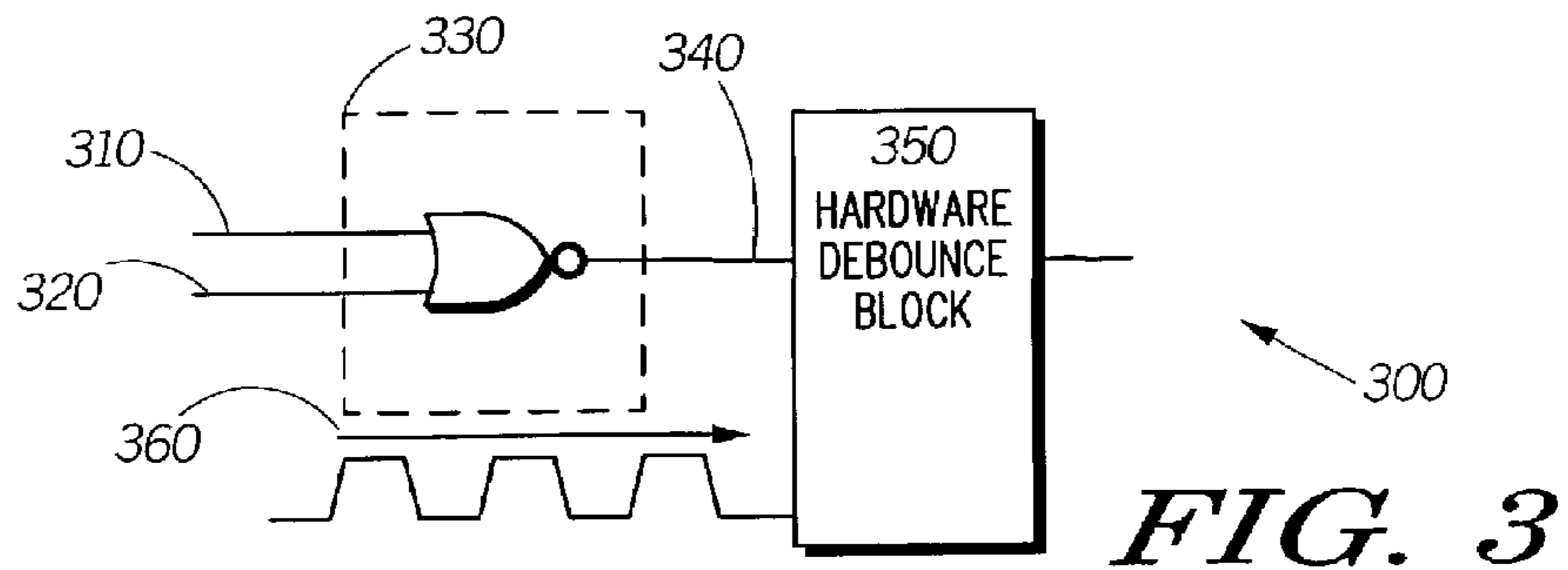


FIG. 2



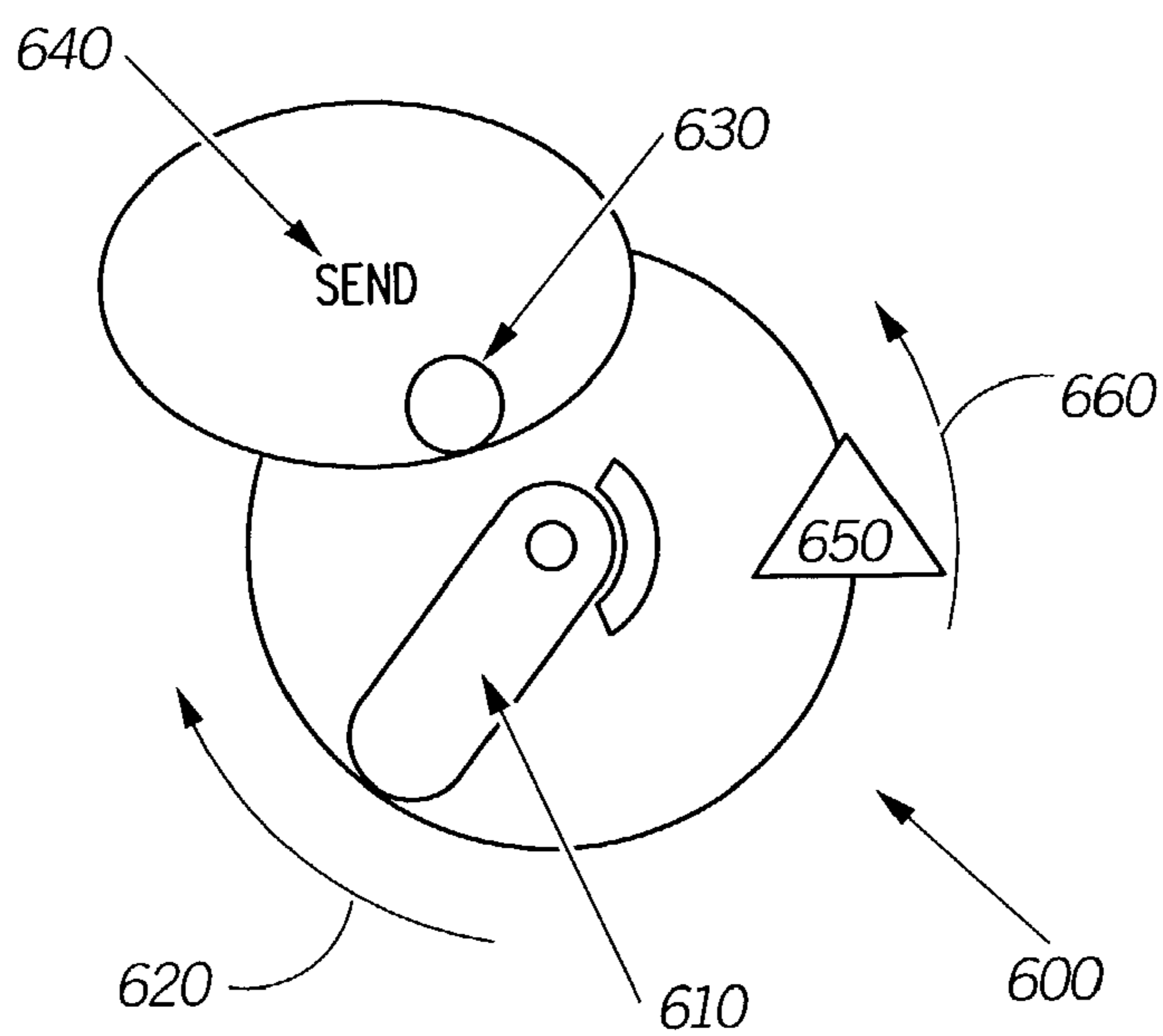


FIG. 6

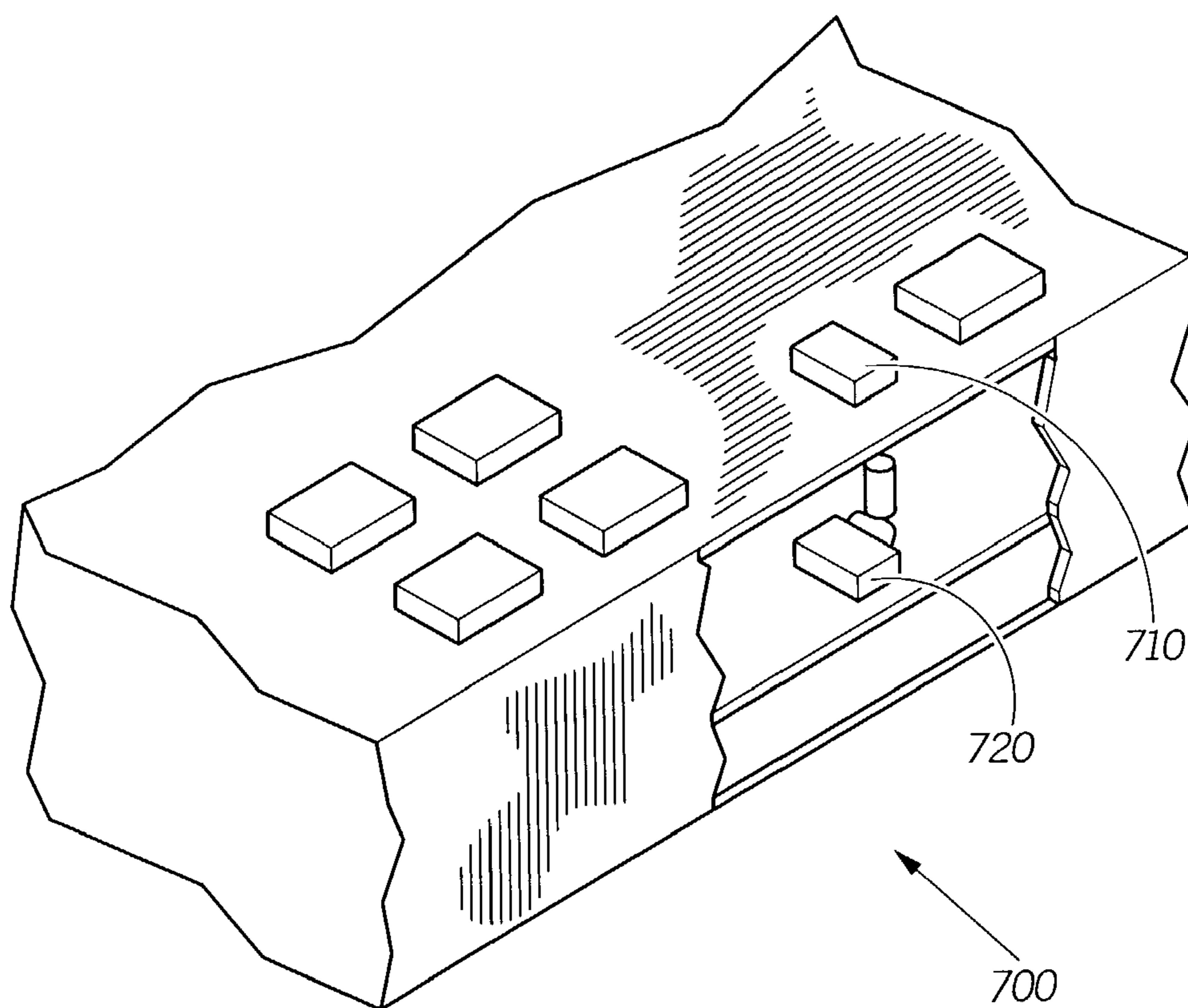


FIG. 7

SYSTEM AND METHOD FOR E911 LOCATION PRIVACY PROTECTION

TECHNICAL FIELD

The invention relates generally to wireless communications. More specifically, the invention relates to mechanisms to selectively enable or disable GPS circuitry in a cellular telephone or other communications device.

BACKGROUND OF THE INVENTION

The Federal Communications Commission (FCC) has mandated that, by December 2002, all cellular telephone carriers must market handsets capable of providing an emergency locator service. This emergency locator service, known as E911, will enable personnel at the public safety answering point (PSAP) to pinpoint the location of a cellular telephone user dialing 911. This FCC mandate further requires that the user not be able to override the emergency locator service in the case of a 911 emergency call.

This technology has raised public concern that, in addition to being used for emergency location, the locator service may be used by cellular carriers or by others to track the movements of cell phone users without their consent. There is therefore a need for a system that complies with the FCC mandate for location service while providing maximum privacy protection for cell phone users.

One technology that is commercially used to attempt to protect the privacy of cellular telephone users is the *67 dialing feature offered by Bell South™ and others. This feature allows a cellular user to block caller ID transmission from a cellular handset by dialing *67 before placing a call. If the user dials *67 and then 911, however, caller ID transmission will not be blocked, and personnel at the PSAP will be able to view the caller ID data.

While this technology can be used to prevent the transmission of caller ID data, it does not protect against the collection or transmission of GPS location data. There is therefore a need for a system that can be used to selectively enable and disable the transmission of GPS location data, preserving the transmission of that data during true emergency calls but blocking the accidental or malicious activation of the GPS tracking feature. Other problems exist.

SUMMARY OF THE INVENTION

The invention overcoming these and other problems in the art relates in one regard to a system and method for selectively activating or deactivating E911 tracking service, in an embodiment by disabling power to GPS locator circuitry in a cellular telephone until the key sequence "9-1-1-Send" is detected. In one embodiment, the power to the GPS circuitry in a cellular handset may be activated by detection of a keypad sequence and the rotation of a physical switch to permit power delivery. When the handset detects the key sequence "9-1-1" it may output a signal that loads the switch into a "ready" position. When the user presses the "Send" button, the switch closes, enabling power to be delivered to the GPS circuitry. In other embodiments, the selective delivery of power may be controlled by software.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a cellular telephone system according to an embodiment of the invention.

FIG. 2 is a diagram of a keypad matrix according to an embodiment of the invention.

FIG. 3 illustrates keypad logic according to an embodiment of the invention.

FIG. 4 is a state diagram of a finite state machine for control processing according to an embodiment of the invention.

FIG. 5 is a state diagram of a finite state machine for control processing according to another embodiment of the invention.

FIG. 6 is a diagram of a mechanical switch mechanism according to an embodiment of the invention.

FIG. 7 is a diagram of a privacy bypass switching system according to an embodiment of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

FIG. 1 illustrates a block diagram of a cellular telephone system 100 in accordance with an embodiment of the invention. The cellular telephone system 100 may include an integrated GPS receiver 110 and GPS antenna 115. The cellular telephone system 100 may further contain a baseband processor 130 that is coupled to RF/audio circuitry 120, for instance via a serial control interface (SPI) and a synchronous serial interface (SSI), or other connections.

The baseband processor 130 may execute software known as modem software or otherwise to control the RF/audio circuitry 120 and access a radio channel. The baseband processor 130 may also interface to the GPS receiver 110 via a Universal Asynchronous Receiver/Transmitter (UART) or other connection.

In a 911 emergency call, the modem software may request a location fix from the GPS receiver 110 and forward the obtained location data to the E911 call center, Public Safety Answering Point (PSAP) or other control point using the RF/audio circuitry 120. In addition to executing the modem software, the baseband processor 130 may also execute other software including application software, such as a Java™ application, a Wireless Application Protocol (WAP) browser or others. Application software may independently request a location from the GPS receiver 110. If the request is granted, the application may receive the location data from the GPS receiver 110 and transmit the location, for instance via the UART.

In some cases, the user may wish to deny the delivery of location data to the application software. For this reason, the cellular telephone system 100 may contain a GPS enabling block 140, which may include a power switch. This GPS enabling block 140 may be coupled to a power bus 150 delivering DC or other power. In normal operation, the GPS enabling block 140 may be open and power to the GPS receiver 110 may be disconnected. This ensures that the GPS receiver 110 does not send location data to a local or remote application without the user's consent.

The cellular telephone system 100 may further contain 911-detect/control circuitry 160 coupled to the GPS enabling block 140. The function of this control circuitry is to ensure that the power to the GPS receiver 110 may be enabled when a 911 emergency call is made and a location fix is necessary. The FCC mandate requires that the user not be able to override the locator service when an emergency call is made. A user-controlled switch to activate the GPS receiver is therefore not fully compliant with the mandate, as a user could disable the locator mechanism in the case of a E911 call. 911-detect/control circuitry 160 consequently automatically enables power to the GPS circuitry when an E911 call is made.

When the 911-detect/control circuitry **160** detects the key sequence “9-1-1,” it may assert a control signal 911_detect, which may activate the GPS enabling block **140**. When the “Send” key is depressed, the GPS enabling block **140** may act to connect the power bus **150** to the GPS receiver **110**. The baseband processor **130** may then send a location request to the GPS receiver **110**, via the UART or otherwise. The GPS receiver **110** may obtain the location data for the cellular telephone system **100**, and forward the data to the baseband processor **130** over the UART or other interface.

The baseband processor **130** may then communicate the location data via the RF/audio circuitry **120** through, for instance, a base station and mobile switch (MSC) to the PSAP or other control point. Once the E911 call is completed, the modem software running on the baseband processor **130** may assert a reset signal. This signal may cause the GPS enabling block **140** to disconnect power from the power bus **150**, disabling power to the GPS receiver **110**, and also causing the 911-detect/control circuitry **160** to return to a surveillance state.

In some cases, the user may wish to selectively allow an application to obtain location data not during an emergency call. In an embodiment, the cellular telephone system **100** may also contain a privacy bypass switch **170** coupled to the power bus **150** and the GPS receiver **110** to activate this option. When the user presses a privacy bypass key (for example, bypass button **710** illustrated in FIG. 7), the privacy bypass switch **170** may close. This may establish an alternate path from the power bus **150** to the GPS receiver **110** that circumvents the GPS enabling block **140** to enable power to drive the GPS receiver **110**. The privacy bypass option may allow the user to override the location avoidance mechanism, and enable the GPS circuitry at selected or all times. With the privacy bypass switch **170** engaged, any software application running on the baseband processor **130** may therefore request and utilize location data until that selective operation is deactivated.

There are different ways to implement the 911-detect/control block **160** and the GPS enabling block **140**. Each of these blocks may be implemented in hardware, in software, in firmware or mechanically, or a combination of those techniques. It is possible that certain software or firmware implementations may be less secure than mechanical guards, although those implementations may in cases cost less to install. For example, if a software implementation of the 911-detect/control block **160** and the GPS enabling block **140** is used, it may be possible for a wireless software application, such as a Java™ virus or a WAP script downloaded via the wireless carrier, to activate the GPS receiver **110** and determine the user’s position.

For this reason, in embodiments the 911-detect/control block **160** may be implemented entirely in hardware logic and the GPS enabling block **140** implemented as a physical switch, such as a motorized electro-mechanical switch or other device. In embodiments, a keypad detect system may therefore be used to ensure that the inputs to the 911-detect/control block **160** are only asserted when a user physically strikes or depresses a key.

In embodiments of the invention, software or firmware may be employed exclusively, or in combination with some mechanical or electronic components, to selectively activate the GPS receiver **110**. In one such embodiment of the invention the GPS enabling block **140** may be implemented as a physical switch such as a motorized electromechanical switch or other device, while the 911-detect/control block **160** may be implemented in software or firmware. In another

embodiment, both the GPS enabling block **140** and the 911-detect/control block **160** may be implemented in software.

In this latter embodiment, registers may contain a Boolean or other variable, for example as “GPS_enabled” or other, to determine whether the transmission of GPS location data is currently permitted. The control software of the 911-detect/control block **160** may set this variable, in this embodiment. If the collection and/or transmission of GPS data is not allowed, the software may block this transmission by disallowing the application to make a location request to the GPS circuitry, by disallowing the UART to transmit GPS data, or by other action.

FIG. 2 illustrates a diagram of a keypad matrix **200** in accordance with an embodiment of the invention. The keypad matrix **200** contains a plurality of keys **210a-l** arranged in predetermined rows and columns. The plurality of keys **210a-l** may be arranged such that each key in the set can be uniquely identified by its corresponding row and column. The keypad matrix **200** may connect to a plurality of row interconnects **220a-d**, each row interconnect corresponding to a row of keys in the matrix. The keypad matrix may also connect to a plurality of column interconnects **230a-c**, each column interconnect corresponding to a column of keys in the matrix. Each of the row interconnects **220a-d** and each of the column interconnects **230a-c** may be connected to a voltage pull-up.

The keypad matrix **200** may further contain a ground plate **240** situated beneath the keypad. When a user strikes a key, the row interconnect and the column interconnect corresponding to the key may be shorted to the ground plate **240**. The row interconnects **220a-d** and the column interconnects **230a-c** may be connected to a keypad decoder logic block **250**, which senses key contact and determines which key has been pressed.

FIG. 3 illustrates keypad logic **300** according to an embodiment of the invention. The keypad decoder logic block **250** of FIG. 2 may include a plurality of keypad logic systems **300**. Each keypad logic system **300** in the decoder logic block **250** may correspond uniquely to one key in the plurality of keys **210a-l**. The first input to the logic system, row_input **310**, may be connected to the row that corresponds to this particular key. The second input, column_input **320**, may be connected to the column that corresponds to this particular key. The logic system **300** further includes logic **330**, which may be implemented as a NOR or other logical gate.

When the key corresponding to the logic system **300** is pressed, the row and the column corresponding to the key may be shorted to ground, and the inputs **310** and **320** may be set to a logical “0.” The logic **330** then asserts the output signal **340**. This output may then be routed to a hardware debouncer circuit **350**. The hardware debouncer block **350** may additionally receive a clock input **360**. The hardware debouncer circuit **350** serves to eliminate spurious key strokes by verifying that the key is continuously pressed for a minimum amount of time.

FIG. 4 illustrates a state diagram of a control processor for controlling operation of the cellular telephone system **100**, which may consist of or include a finite state machine (FSM), according to an embodiment of the invention. A FSM is one implementation of the 911-detect/control block **160** of FIG. 1, which functions to assert a control signal 911_detect when it detects the key sequence “9-1-1.” The FSM in this embodiment may for instance be represented or implemented as a hardware logic state machine, for instance a Moore machine. The control operation is as follows: the control processor, such as a microprocessor, microcontroller, digital signal pro-

cessor or other device may begin in an initial state **400**. The initial state **400** can be entered in a number of ways.

For example, this state may be entered when the cellular telephone system **100** first powers up, when a call is ended, after a keypad entry has timed out or at other times. The modem software running on the baseband processor **130** may detect the situations in which it is desirable for the control processor to enter the initial state **400**, and will assert a signal `switch_init` that causes the device to enter the initial state. From the initial state **400**, if a “9” input is detected, the control processor may enter the 9-detect state **410**. If any other input is detected while the control processor is in the initial state **400**, the control processor may remain in the initial state.

From the 9-detect state **410**, if a “1” input is detected, the control processor may enter the 9-1-detect state **420**; if any other input is detected, the control processor may enter the initial state **400**. From the 9-1-detect state **420**, if a “1” input is detected, the control processor may enter the 9-1-1-detect state **430** and the output `911_detect` is asserted. If any other input is detected, the control processor may enter the initial state **400**. In the case of a 911 emergency call, the reset signal `switch_init` may be asserted when the call is ended, returning the control processor to the initial state **400**.

It may be noted that the control logic described above may assert the `911_detect` signal in the case of any key sequence including the key strokes “9-1-1.” However, by law no telephone number may begin with the numerical sequence “9-1-1.” Furthermore, for phone numbers in which the numerical sequence “9-1-1” is in the middle of the phone number, for example the phone number 643-9112, or for other keypad inputs such as wireless email text which might include a “9-1-1” string, power to the GPS circuitry will not be enabled. In this example, the `911_detect` signal may be asserted after the key strokes “643-911” are detected; however, when the “2” key is detected, the control processor may return to its initial state **400** and the `911_detect` signal may be deasserted. Therefore, the control signal will not be asserted when the “Send” key is depressed, and power to the GPS circuitry may not be enabled.

Even considering the bar on phone numbers including the numerical sequence “9-1-1,” it may be desirable to implement the 9-1-1 logic detect circuit in an embodiment, to provide increased protection against inadvertent enabling of the GPS circuitry. In this case the control logic may ensure that the `911_detect` signal was asserted only in the case where the key sequence “9-1-1” was detected without any preceding key strokes. One such embodiment is shown in FIG. 5.

FIG. 5 shows a state diagram of a control processor for controlling operation of the cellular telephone system **100**, again consisting of or including a finite state machine, according to an embodiment of the invention. A software-controlled FSM may be one implementation of the 911-detect/control block **160** of FIG. 1, which functions to assert a control signal `911_detect` when it detects the key sequence “9-1-1” with no preceding key strokes. The control processor in this embodiment is similar to the state machine reflected in FIG. 4. However, while the state machine of FIG. 4 is a Moore machine, the control processor illustrated in FIG. 5 may be implemented as a Mealy machine. The associated control logic also differs from that of FIG. 4 in that it eliminates the 9-1-1-detect state **430** and includes an “occupied” state **530**. The control processor enters the occupied state **530** whenever it is determined that a call other than a 911 call is being placed.

The control processor begins in an initial state **500**. The initial state **500** can be entered in a number of ways. For example, this state may be entered when the device first powers up, when a call is ended, after a keypad entry has

timed out or at other times. In an embodiment, the modem software running on the baseband processor **130** may detect the situations in which it is desirable for the control processor to enter the initial state **500**, and may assert a signal `switch_init` that causes the control processor to enter the initial state. If a “9” input is detected while the control processor is in the initial state **500**, the control processor may enter the 9-detect state **510**. If any other input is detected while the control processor is in the initial state **500**, the control processor may enter the occupied state **530**.

From the 9-detect state **510**, if a “1” input is detected, the control processor may enter the 9-1-detect state **520**; if any other input is detected, the control processor may enter the occupied state **530**. From the 9-1-detect state **520**, if a “1” input is detected, the control processor may enter the initial state **500** and asserts the output `911_detect` during the transition. If any other input is detected, the control processor may enter the occupied state **530**. The control processor may remain in the occupied state **530** until the modem software or other input asserts the `switch_init` signal.

FIG. 6 is a diagram of a mechanical switch mechanism **600** according to an embodiment of the invention. The mechanical switch mechanism **600** may contain an arm bar **610**. When the key sequence “911” is detected, the 911-detect logic **160** may output a `911_detect` control signal to a mechanical actuator (not shown). This mechanical actuator may be implemented as a rotary micro-motor, linear actuator or other drive mechanism. When the mechanical actuator receives the `911_detect` control signal, it may become motorized to bias the arm bar **610** to travel in a specified direction **620**. The arm bar **610** may travel in direction **620** until it is stopped by a rigid post or other stopper **630**. This stopper **630** may be located under a “Send” key **640**, and may be affixed to the “Send” key **640** or to the housing support structure (not shown) surrounding the “Send” key **640** or otherwise mounted.

The action of biasing the arm bar **610** such that it causes travel in direction **620** to make contact with the stopper **630** may be referred to as the load phase, and the switch mechanism **600** may be said to be loaded when the arm bar **610** is in contact with the stopper **630**. When the arm bar **610** is in contact with the stopper **630**, the user may depress the “Send” key **640**. This may cause the “Send” key **640** to make physical contact with the arm bar **610**, which in turn sets in motion the arm bar **610** to continue traveling in the specified direction **620** until it makes contact with a switch **650**. When the arm bar **610** makes contact with the switch **650**, power to the GPS receiver **110** may be enabled. The period of time during which the arm bar **610** is in contact with the switch **650** may be referred to as the release phase.

The operation of the mechanical switch **600** may further include a stage referred to as a restore phase. The mechanical switch **600** may enter the restore phase when it is determined that power to the GPS circuitry will not immediately be needed. This may occur when a call other than a 911 call is being made, when a 911 call is completed, when location data has successfully been obtained or otherwise.

Depending on the implementation of the invention, different inputs may trigger the mechanical switch **600** to enter the restore phase. If the 911-detect/control block **160** is implemented using a control processor operating with the control logic illustrated in FIG. 4 or that of FIG. 5, the mechanical switch **600** may enter the restore phase when the modem software asserts the `switch_init` control signal. If 911-detect/control block **160** is implemented according to control logic illustrated in FIG. 4, the mechanical switch mechanism **600** may also enter the restore phase when the control processor deasserts the `911_detect` signal.

This difference in operation is due to the fact that the 911-detect/control block **160** may be implemented at least as either as a Mealy machine or as a Moore machine. The Moore machine illustrated in FIG. **4** asserts the 911_detect signal when the appropriate key sequence is detected, and does not deassert the signal until another key stroke is detected. For this reason, the GPS enabling block **140** used in conjunction with this type of control logic may be activated when the 911_detect signal is asserted, and deactivated when the 911_detect signal is deasserted. In contrast, the control processor illustrated in FIG. **5** operates as a Mealy machine and asserts the 911_detect signal only during the transition between states. For this reason, the GPS enabling block **140** used in conjunction with this type of control logic may be activated when the 911_detect signal is asserted, but may not be deactivated until the modem or other software asserts the switch_init signal.

During the restore phase, the mechanical actuator elements may be deactivated. This may cause the arm bar **610** to move in a second direction **660**. If the switch **600** is implemented such that the arm bar **610** moves linearly, the second direction **660** may be the opposite direction of the first direction **620**. If the switch **600** is implemented such that the arm bar **610** moves in an arc, the first direction **620** may be clockwise and the second direction **660** may be counterclockwise, or vice versa. During its return, the arm bar **610** may interface with the stopper **630**. However, the arm bar **610** may be constructed such that it is rigid in the initial direction but compliant on the return direction. The arm bar may therefore be able to return to its original position.

FIG. **7** is a diagram of a privacy bypass switching system **700** according to an embodiment of the invention. The privacy bypass switching system **700** is one possible implementation of the privacy bypass switch **170** illustrated in FIG. **1**. The privacy bypass switch **700** may contain a privacy bypass button **710** which may be or include any button, switch, or software variable such that when the privacy bypass button is in an "on" state, power is enabled to the GPS circuitry, and software applications may request location information from the embedded GPS receiver **110**.

In the privacy bypass system **700**, when the user may engage the privacy bypass button **710**, the button may make physical contact with a switch **720** located thereunder. In one embodiment, the privacy bypass switch **720** may be the same type of device as the 911-detect switch **650** which is controlled by the logic block **160**. In this case, depressing the privacy bypass button **710** may provide a technique for closing the switch **720** that is independent of that described in conjunction with FIG. **6**. In another embodiment, the privacy bypass switch **720** may be a separate switch from the 911-detect switch **650**. In this case, the switch **720** may be incorporated into an alternate path between the power bus and the GPS receiver **110**. This alternate path may circumnavigate the switch **650**. For either implementation, when the privacy bypass button **710** is in the "on" state, power may be enabled to the GPS circuitry, and software applications may request location information from the embedded GPS receiver **110**. This alternate path may circumnavigate the switch **650**. For either implementation, when the privacy bypass button **710** is in the "on" state, power may be enabled to the GPS circuitry, and software applications may request location information from the embedded GPS receiver **110**.

The foregoing description of the invention is illustrative, and modifications in configuration and implementation will occur to persons skilled in the art. For instance, while the invention has generally been described in terms of a hybrid cellular/GPS device, in embodiments other devices, such as

two-way pagers, wireless network-enabled computers or other clients or devices may be configured with GPS protection according to the invention.

In another regard, while the invention has generally been described as activating or controlling the collection and/or transmission of GPS location data triggered upon an initial "9-1-1" keypad sequence, in embodiments the device may be controlled based upon other key sequences, for instance if future sequences were designated for emergency purposes, or otherwise. In yet another regard, while the invention has generally been described in terms of regulating the collection and/or transmission of GPS location data by applying or removing electrical power to associated circuits, in embodiments other actions may be taken to render GPS location data available or unavailable, such as by decoupling the GPS antenna when a key stroke sequence is detected. The scope of the invention is accordingly intended to be defined only by the following claims.

We claim:

1. A method for enabling operation of GPS circuitry in a mobile wireless device, the method comprising:
 - disabling the GPS circuitry via a GPS enabling block of the mobile wireless device responsive to a user selection to disable the GPS circuitry, wherein disabling includes removing power from the GPS circuitry, and wherein the mobile wireless device otherwise remains operational, the disabling performed responsive to a user input to disable the GPS circuitry to prevent sending location data without consent of a user of the mobile wireless device;
 - detecting, via detect/control circuitry disposed in the mobile wireless device, an input at a keypad of the mobile wireless device from a user of the mobile wireless device, the input representing an emergency call; and
 - enabling the GPS circuitry despite prior disablement of the GPS circuitry by the GPS enabling block, by providing power to the GPS circuitry in spite of the user selection, performed by the detect/control circuitry, and performed upon detection of the input representing the emergency call.
2. The method of claim 1, wherein the step of detecting an input at a keypad of the mobile wireless device comprises detecting at least a predetermined sequence of key strokes representing an emergency call number and wherein the first key strokes of the predetermined sequence of key strokes comprise the key strokes "9-1-1."
3. The method of claim 1, wherein the mobile wireless device comprises a cellular telephone.
4. The method of claim 3, wherein the cellular telephone comprises an embedded GPS receiver.
5. A method for operating a mobile wireless device that includes GPS circuitry to determine location data associated with a location of the mobile wireless device and a user interface to accept one or more inputs from a user of the mobile wireless device, the method comprising:
 - disabling the GPS circuitry responsive to a first user input, while otherwise maintaining operability of the mobile wireless device, so as to prevent wireless communication of location data determined by the GPS circuitry from the mobile wireless device without subsequent consent to communication of the location data by the user of the mobile wireless device;
 - detecting at least a second user input representing an emergency call, but not consent to communication of the location data;

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automatically enabling the GPS circuitry responsive to detecting the at least a second user input despite prior disablement of the GPS circuitry; and
 after automatically enabling the GPS circuitry, wirelessly communicating the location data despite a lack of consent from the user of the mobile wireless device. 5

6. The method of claim **5**, wherein the user interface is a keypad and the at least a second user input includes entry of an emergency call number into the keypad.

7. The method of claim **6**, wherein the emergency call number is 911. 10

8. A mobile wireless device comprising:
 a user interface operable to receive one or more inputs from a user of the mobile wireless device;

GPS circuitry operable, when enabled, to determine location data associated with a location of the mobile wireless device; 15

a GPS enabling block coupled to the user interface and operable to selectively enable or disable the GPS cir-

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cuitry, the GPS enabling block disabling the GPS circuitry responsive to a first user input so as to prevent wireless communication of location data determined by the GPS circuitry without subsequent user consent to communication of the location data;

detect/control circuitry coupled to the GPS circuitry and the user interface, the detect/control circuitry enabling the GPS circuitry, despite prior disablement of the GPS circuit, by the GPS enabling block, responsive to detecting at least a second user input representing an emergency call, but not consent to communication of the location data; and

radio circuitry coupled to the detect/control circuitry and the GPS circuitry, the radio circuitry wirelessly communicating at least the location data despite a lack of consent to communication of the location data by the user.

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